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Experiment on Water Absorbing and Surface Pore Property of Concrete

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Abstract

In the purpose of finding the relationship between the pore property and water absorbing property of concrete of different strength, scanning electron microscope (SEM for shot) is used to observe the pore in the concrete as well as computer software is used to gain the box counting dimension, water absorbing experiment is also done to the concrete to figure out the water absorbing curve. It's found that the water absorbing property has nothing to do with the strength of concrete; C30 concrete has the lowest box counting dimension and poorest ability absorbing water among the concrete C20, C30 and C40.

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Keywords: Concrete; Scanning electron Microsope; water absorbing; pore property

1. Introduction

Dewing in the building is a problem paid more and more attention by people as the development of living standards. If the temperature of the surface of wall is lower than the dew point temperature of the air nearby, it will dew in the surface. Dew may change the appearance and the shape of the ornamental and even exfoliate it. At the same time, liquid water will move to the inner part of the wall, which may destroy the construction and the metal parts in it, or even germs may breed to make secondly disaster.

Concrete is the most general metal in living building, it's made of different proportion of cement, sand and gravel, in which cement is glue to cohere sand and gravel in the fluent of water and other additives. There are 14 classes of

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concrete of different strength, named C15, C20, C25 ⋯ C80 [1] in which C20, C30 and C40 are most widely used in living building. Concrete is a kind of porous material, the ones in different strength have different proportion, which leads to different pore structure and pore size distribution in it, as a result, ability to absorb water is not all the same for concrete in different strength.

Scanning electron microscope, SEM for shot, is invented in 1965; it has high amplification factor, big field of view and long depth of field. SEM can be used to observe all kinds of un-even surfaces directly and save the results as images, which make it a widely used instrument for science research.

Fractal geometry theory is used to study random and complex phenomenon, it's widely ap-plied to natural and social science and develop very fast in these two decades. As a porous material, pores are randomly distributed in concrete, so pore structure in concrete can be stud-ied with fractal geometry theory [2]. Box counting dimension is one of the most widely used fractal dimension, it covers the object with boxes which length of side is ε, count the number N(ε) of boxes which is not empty, then shrink the size of the box ε, count the number N(ε) of boxes which is not empty, by such analogy, curve of lgN(ε) and lgε can be drawn, the slope of the curve means the box counting dimension DB of the object [3].

There are many methods to measure the water absorbing ability of materials, such as gamma-ray attenuation method and nuclear magnetic resonance method, however, it is proved in the examination that result of water absorbing experiment is also a good method to measure it [4]. For this reason, water absorbing experiment can be used to measure the ability of concrete to absorb water.

2. Methods

Observe any section of concrete in the magnification of 250 under S-4800 SEM and save the image, convert the grey scale image into black-and-white image, and then use a fractal dimension software to analysis the image with the scale of boxes 8-100 are selected, so we can get the box size (δ) and the number N(δ) of them. Microsoft Office Excel is applied to compute the common logarithms of δ and N(δ), then we found a linear relation between lgδ and lgN(δ). After the data fitted, we get a straight line of which the slope means the box counting dimension of this field.

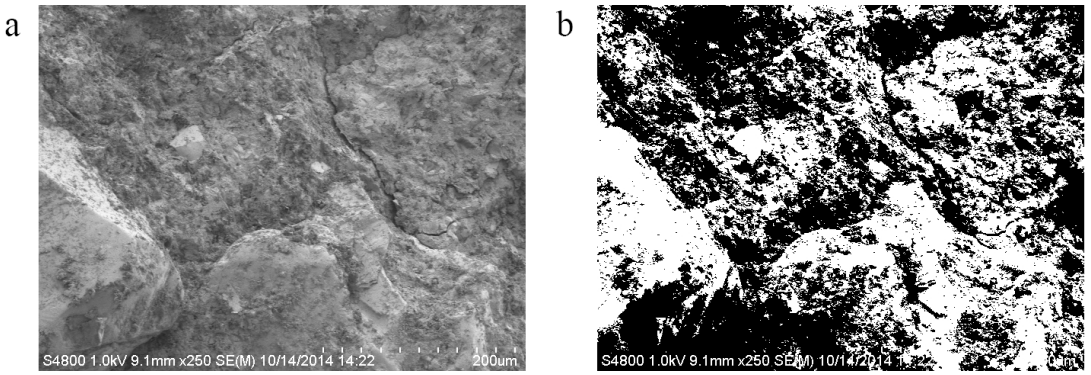

Fig. 1. (a) Image of concrete C20 before converting; (b) Image of concrete C20 after converting.

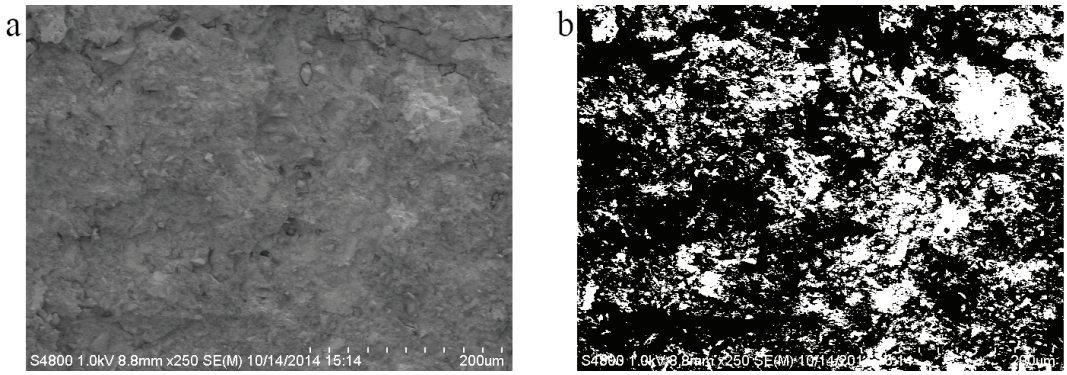

Fig. 2. (a) Image of concrete C30 before converting; (b) Image of concrete C30 after converting.

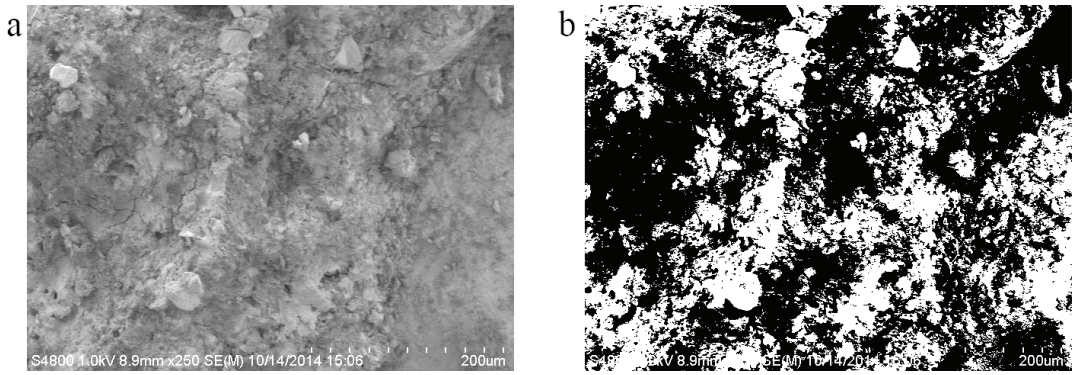

Fig. 3. (a) Image of concrete C40 before converting; (b) Image of concrete C40 after converting.

Respectively make three blocks with concrete C20, C30 and C40 which length of sides are 7cm, make an air-and –water proofing skin with glass cement on the four surfaces around the blocks after maintenance. Weigh the block, measure the area of the under surface and immerge it into the water if the glass cement is dry.

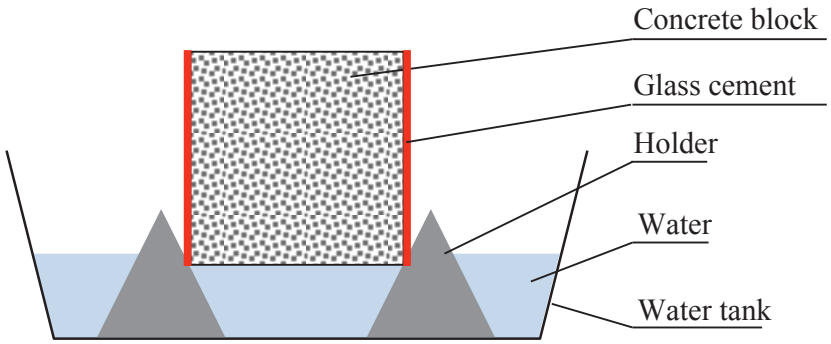

Fig. 4. Examination apparatus.

Weigh the block every hour in the first four hours of the examination, then weigh it every two hours during the 4th to 10th hours, and in the 10th to 24th hours, weight it every 4hours. Weigh should stop if the weight raises less than 1gin 8hours and all the time points and weight data should be recorded correspondingly.

With the data got from the examination, the relationship between the mass of water absorbed within a unit area (kg/m^2) and the square root of time ($t^{0.5}$) can be measured and drawn into a chart, a linear fitting curve can also be given which the slope means the water absorbing efficiency ($kg/m^2 \cdot t^{0.5}$).

Compare the results of water absorbing experiment and SEM experiment, the relationship be-tween the ability of water absorbing and box counting dimension can be worked out.

3. Results

Through the SEM examination data, fitting curve between common logarithms of box size (lg(δ)) and number (lgN(δ)) of concrete can be drawn, as is shown in figure 5 to figure 7.

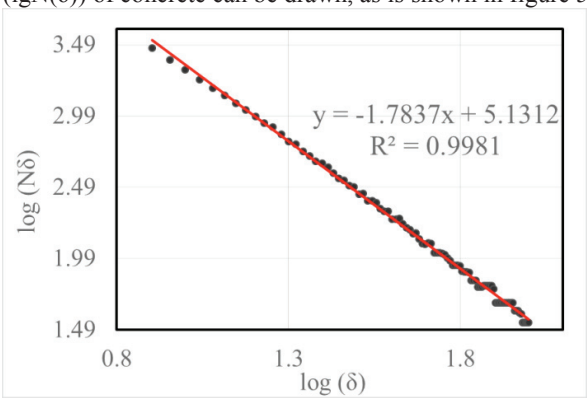

Fig. 5. Fitting curve of box counting dimension for concrete C20

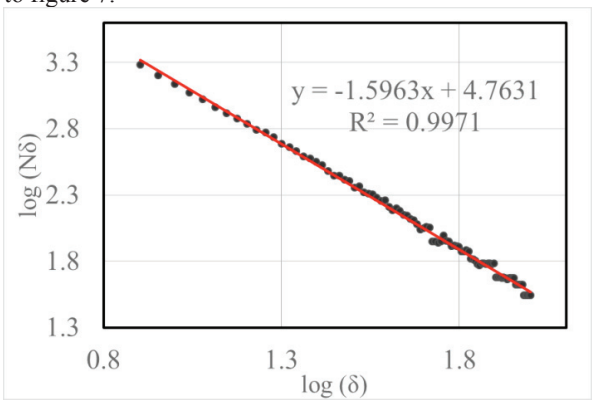

Fig. 6. Fitting curve of box counting dimension for concrete C30.

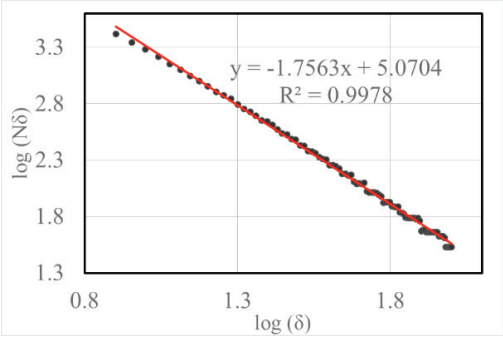

Fig. 7. Fitting curve of box counting dimension for concrete C40.

As is shown in the figures, the box counting dimension of concrete has nothing to do with its strength, the box counting dimension of concrete C20 is the biggest while that of concrete C30 is the smallest.

With the data of water absorbing examination dealt with computer program, the curve of the relationship between the mass of water absorbed within a unit area and the square root of time can be drawn. After linear fitting, water absorbing efficient of concrete can be read from the slope of the line.

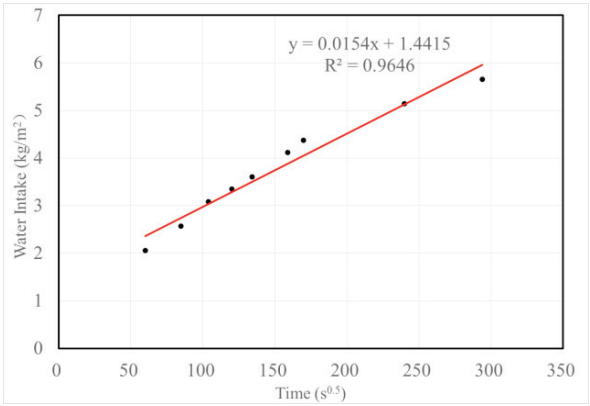

Fig. 8. Fitting curve of water absorbing property for concrete C20.

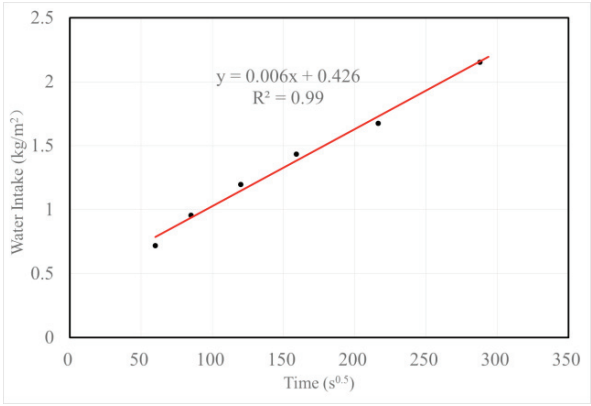

Fig. 9. Fitting curve of water absorbing property for concrete C30.

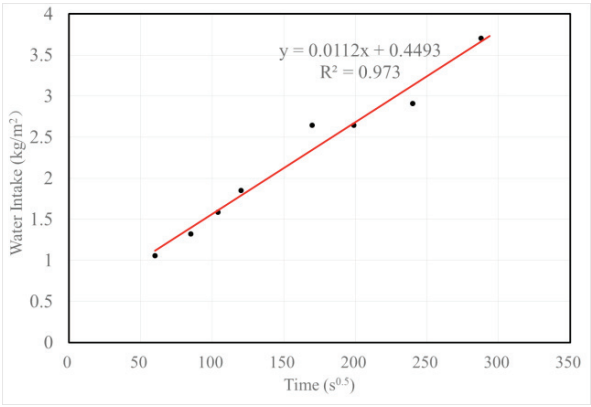

Fig. 10. Fitting curve of water absorbing property for concrete C40.

It's obviously that concrete C20 is most effectively absorbing water, while concrete C30 the less effective.

4. Discussion

The water absorbing efficiency of concrete has nothing to do with its strength, it's the pore structure that may matter. According to the specification[5], concrete C20 uses the least cement and the most gravel, concrete C30 uses both these materials in middle, while concrete C40 uses the most concrete and the least gravel. Gravel has smaller pore than that in cement, that means its ability of absorbing water is poorer than cement in short period, however, more gravel means there would be more complex contacting boundaries with cement, that kind of boundaries should be very good storage and moving space for liquid water. On the other hand, for the reason of high proportion of cement, the water ab-sorption ability of concrete C40 is led by cement of good absorbing character. As mix proportion is different from class to class of concrete, when combined, concrete C30 has the least pore structure suit for storing and moving of liquid water than that in concrete C20 and C40, which lead to the gap of water absorbing ability.

It is remarkable that, for some gravel, the pore structure may get changed with the influence of water [6], which may lead to the change of water absorbing ability of concrete.

5. Conclusions

In three kinds of the most widely used concrete C20, C30 and C40, concrete C30 has the least complex pore structure, its box counting dimension is the smallest in these three, as well as its ability to absorb water. In some occasions that demand some degree of water isolation, concrete C30 can be applied if it can also reach the demand of strength and economy. However, impermeable concrete is irreplaceable in certain construction.

Acknowledgements

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